Java, Threads, and Ptolemy

A New Direction for Ptolemy

Ptolemy Miniconference

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Why Java?

- **Because Java is**
  - **Portable**
  - **Distributable (Applets)**
  - **Cleaner than C++**
  - **Threaded**
  - **Buzzword Compliant**
- **Itcl complements Java**
  - **Java is low-level**
  - **Itcl is high-level & scripted**

Building on the Ptolemy Experience

- **Separate Domains (current)**
  - Strict Information Hiding
  - Hierarchical Nesting of Models of Computation
  - Simulation vs Code Generation
- **Integrated Domains (future)**
  - More seamless Programming Model
  - More seamless User Interface
  - Potential for Better Synthesis
  - Modularized Programming Environment
  - Deployable, Modular Design Tools

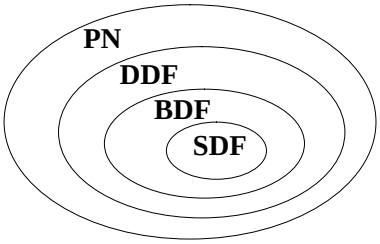
Integrated Domains

- **We have learned a lot**
  - Domains have helped
  - We can exploit what we have learned
- **Models of Computation**
  - Kahn Process Network (PN)
  - Dynamic Data Flow (DDF)
  - Boolean Data Flow (BDF)
  - Synchronous Data Flow (SDF)
  - Finite State Machine (FSM)

Increasing specialization: More efficient execution

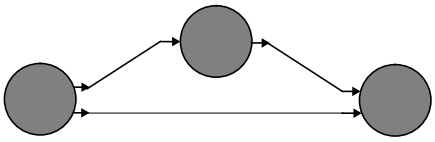
Control

Models of Compuation to be Integrated



- **PN: Sequential processes**
  - **communication via FIFO channels**
  - **blocking read when channel is empty**
- **DDF: Run time firing of actors, mutable graph**
- **BDF: Compile time analysis => firing sequence**
- **SDF: Periodic firing sequence**

Implementing PN in Java



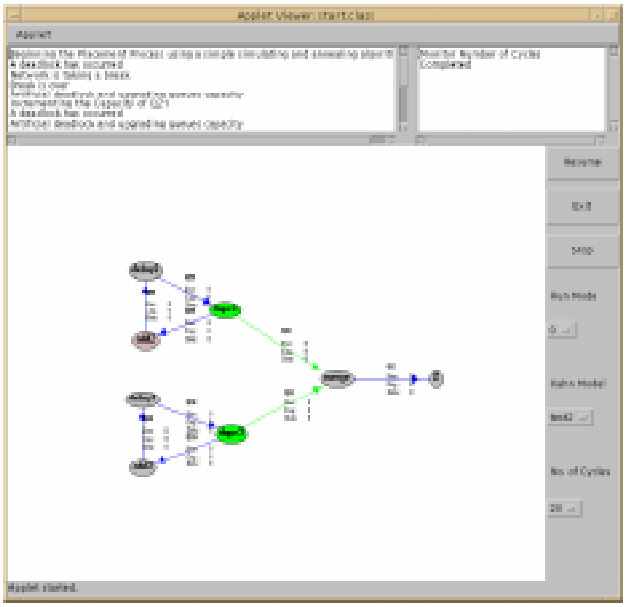
Icon	Object	Implementation
Circle	Process	Thread
Connecting Line	FIFO Channel - Unbounded - Blocking Read	List - Expandable - Wait & Notify

PN vs Java Threads

- **Threads are low-level & non-determinate**
- **PN is high-level & determinate**
- **Use Java Threads to implement higher level concurrence model**

Prototype PN in Java

Student Project for EE290N, Fall '96



- Participants
  - Peggy Laramie
  - Marlene Wan
  - Dick Stevens
- Define Processes
- Connect Processes
- Run

Technical Issues

- Will a PN eventually halt?
  - In SDF - Decidable in finite time
  - In general - Undecidable
- If not, will it execute in bounded memory?
  - In SDF - Decidable
  - In general- Undecidable
  - Tom Parks: Execute in bounded memory if possible

Executing a PN in Bounded Memory

Tom Parks' Algorithm

- Set a capacity on each channel
- Block write when channel is full
- Repeat
  - Run until deadlock occurs
  - If never deadlocks, then problem solved
  - If deadlock and no blocking writes, then PN halts
  - Among channels that block writes, select one with lowest capacity
  - Increase capacity of selected channel
- Infinite time to decide
  - Whether PN halts
  - Whether PN executes forever in bounded memory

Applet to Generate Primes

- Sieve of Eratosthenes
- Mutable Graph
  - Processes to generate 2, 3, 4, ...
  - Process to filter multiples of 2
  - Dynamically add process for each new prime
- Run from within Tycho using the Tcl/Java interface

Status

- **Project: Prototype demonstration**
  - **Process Networks: Blocking Reads**
  - **Implemented in Java**
  - **Execute in Bounded Memory when possible**
- **Tycho/Java Environment**
  - **Applet to generate primes**
- **Currently Building Java Kernel**

Summary

- **Java implementation for Ptolemy**
  - **Portable, Distributable, Multi-Threaded**
  - **Build on past experience**
  - **Use same Itcl interface**
  - **Merge simulation, code generation**
  - **Merge hierarchical models of computation**
- **Approach**
  - **Generic Kernel to support multiple domains**
  - **Start with PN domain, PN model**
  - **Add more specialized models DDF, BDF, SDF**
  - **Add other models DE, VHDL, SR, ...**